MINING AND METALLURGY INSTITUTE BOR ISSN: 2334-8836
UDK: 622

UDK: 622.261.2(045)=20 DOI:10.5937/MMEB1401001I

Dragan Ignjatović[*], *Lidija Đurđevac Ignjatović*[*], *Milenko Ljubojev*[*], *Ivan Ivanov*[**]

TESTING THE CARRYING CAPACITY OF ANCHOR IN THE ORE BODY "T1"[***]

Abstract

In order to secure the underground stope in the ore body, "T1", the supporting of excavated area is carried out. The supporting, in this case, is carried out by means of anchors of type SWELLEX and SN, M-20 in a combination with the resin LOKSET RESIN CAPSULES, and reinforcement mesh, which is applied with the layer of torkret concrete.

This work presents the results of testing the carrying capacity of anchors in a given ore body "T1"

Keywords: *excavated area, anchor, anchor carrying capacity, pull-out force*

1 INTRODUCTION

During underground mining, parallel with the ore exploitation, the supporting of excavated area is carried out. Supporting is carried out by means of anchors of type SWELLEX and SN, M-20 in a combination with the resin LOKSET RESIN CAPSULES. Supporting is preceded by drilling of boreholes for installation of anchors. Drilling is done using the drilling equipment BOOMER 282. Hole diameter is ∅ 33 mm.

After installation of anchors, their strain is performed, then the reinforcement mesh is installed and torkret concrete is applied.

After all above actions, testing of carrying capacity of anchors is carried out on a pull-out force using a hydraulic pump. Testing of carrying capacity of anchors is carried out according to the recommendations of the International Society for Rock Mechanics (ISRM).

In addition to the pull-out force, displacements of anchor head are also carried out. Pull-out force is applied gradually to achieve the set (working) or limit pull-out force.

The results of testing the carrying capacity of anchors are presented by graphic diagrams of movements in the function of pull-out force.

1.1 Analysis of test results

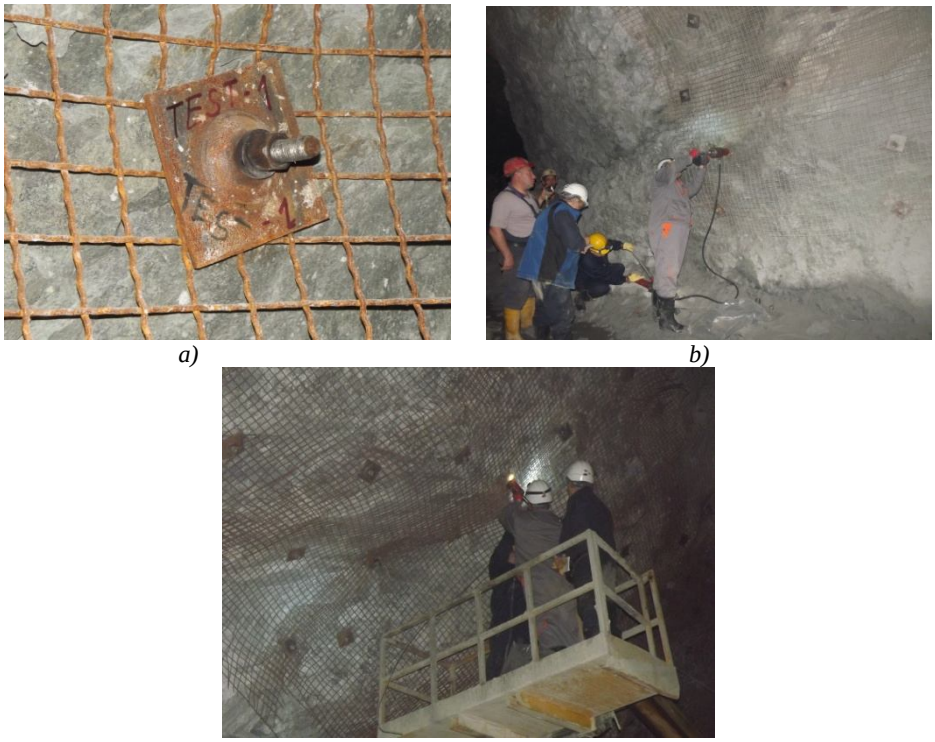
Measurements were performed twice (20.11.2013 and 23.01.2014) on 6 anchors, which are built on the specific places in the ore body T1.

Figures 1.1 a, b and c show a view of anchor testing in the ore body T1.

[*] *Mining and Metallurgy Institute Bor*

[**] *RBB "Jama" Bor*

[***] *This work is the results of the Project No. 33021 "Research and Monitoring the Changes of Stress Strain State of the Rock Mass "IN SITU" Around the Underground Rooms with Development of Model with the Special Reference to the Tunnel of the Krivelj River and the Underground Mine "Jama" Bor" funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.*



a) *b)*

c)

Figure 1.1 *a), b) and c) Testing of anchors - determining the pull-out force*

Table 1.1 gives the values of displacement in a function of pull-out force for tested anchors.

Table 1.1 *The values of displacement (Δl, [mm]) in the function of pull-out force – carrying capacity (F, [kN])*

Anchor – testing place					
Test 1, room side K-145		**Test 2, right side K-145**		**Test3, left side, K-145**	
Δl, [mm]	**F, [kN]**	**Δl, [mm]**	**F, [kN]**	**Δl, [mm]**	**F, [kN]**
4.30	18.64	7.00	18.64	1.00	9.32
8.80	46.60	-	-	2.60	18.64
10.00	55.92	-	-	3.30	37.28
11.30	65.24	-	-	4.20	46.60
12.60	74.56	-	-	4.80	55.92
14.20	83.88	-	-	5.00	65.24
15.70	82.30	-	-	5.80	74.56
-	-	-	-	7.00	83.88

Table 1.1 - *continued*

Anchor – testing place					
Test 1, right side K-123		**Test 2, right side K-123**		**Test 3, roof of room K-123**	
Δl, [mm]	**F, [kN]**	**Δl, [mm]**	**F, [kN]**	**Δl, [mm]**	**F, [kN]**
7.10	18.64	3.00	18.64	2.00	18.64
7.60	27.96	3.20	27.96	6.10	27.96
8.20	37.28	4.00	37.28	7.50	37.28
8.40	46.60	5.90	46.60	10.50	46.60
8.50	55.92	6.00	55.92	11.00	55.92
9.20	65.24	7.10	65.24	13.00	60.58
13.30	74.56	7.40	74.56	14.00	65.24
15.90	83.88	8.00	83.88	14.80	74.56
17.70	93.20	9.80	93.20	15.00	83.88
18.60	102.52	9.90	102.52	15.10	93.20
19.40	111.84	10.00	111.84	16.00	102.52
23.50	121.16	12.90	121.16	16.30	111.84
26.00	130.48	13.00	130.48	16.50	121.16
27.00	135.14	13.50	139.80	25.50	130.48
-	-	16.70	149.12	-	-
-	-	17.40	153.78	-	-

The results of measuring the pull-out force are graphically present in further text.

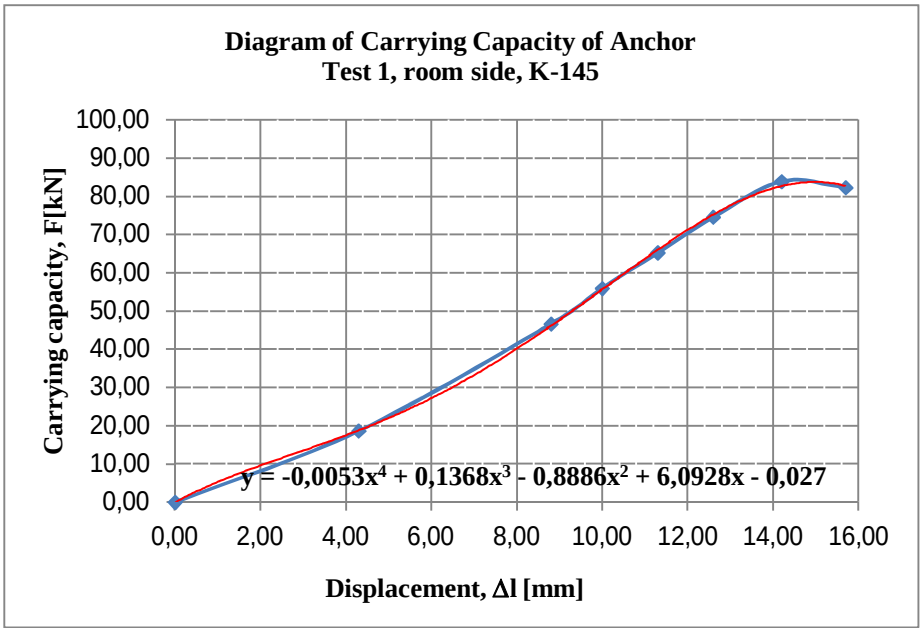


Figure 1.2 *Results of measuring the pull-out force of the first anchor of the first test series*

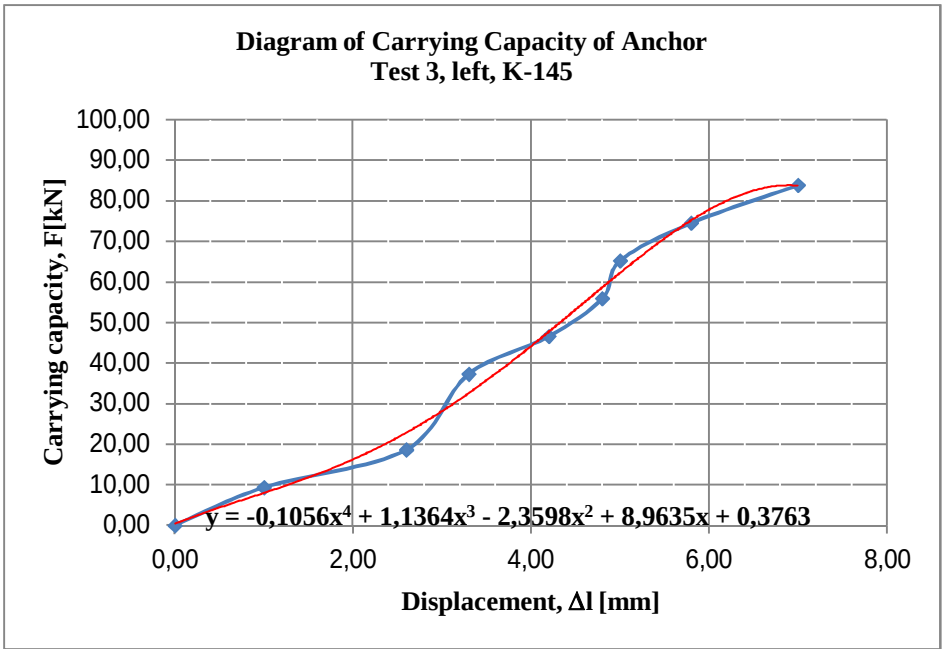


Figure 1.3 *Results of measuring the pull-out force of the third anchor of the first test series*

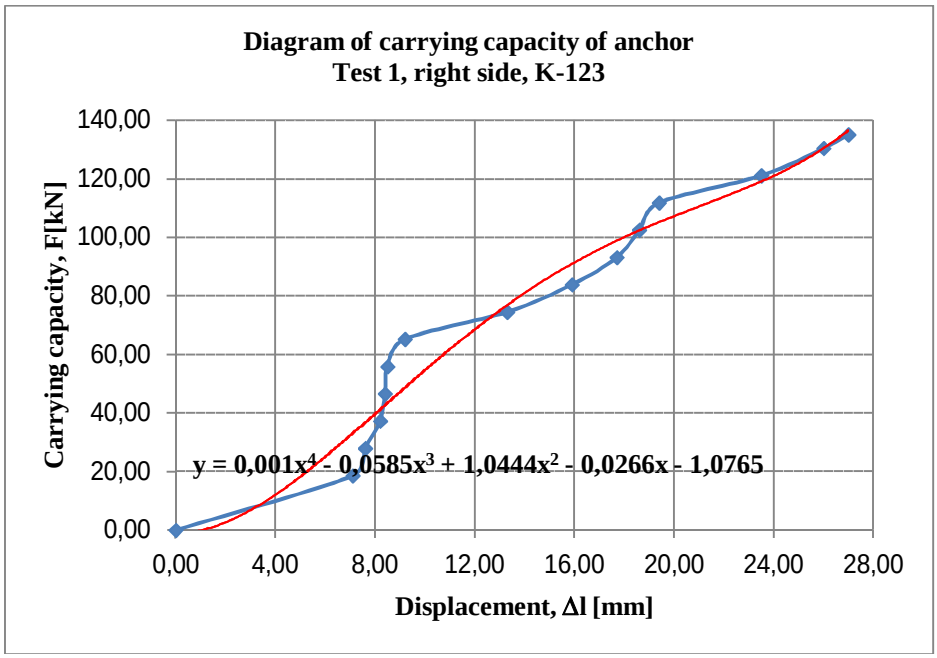


Figure 1.4 *Results of measuring the pull-out force of the first anchor of the second test series*

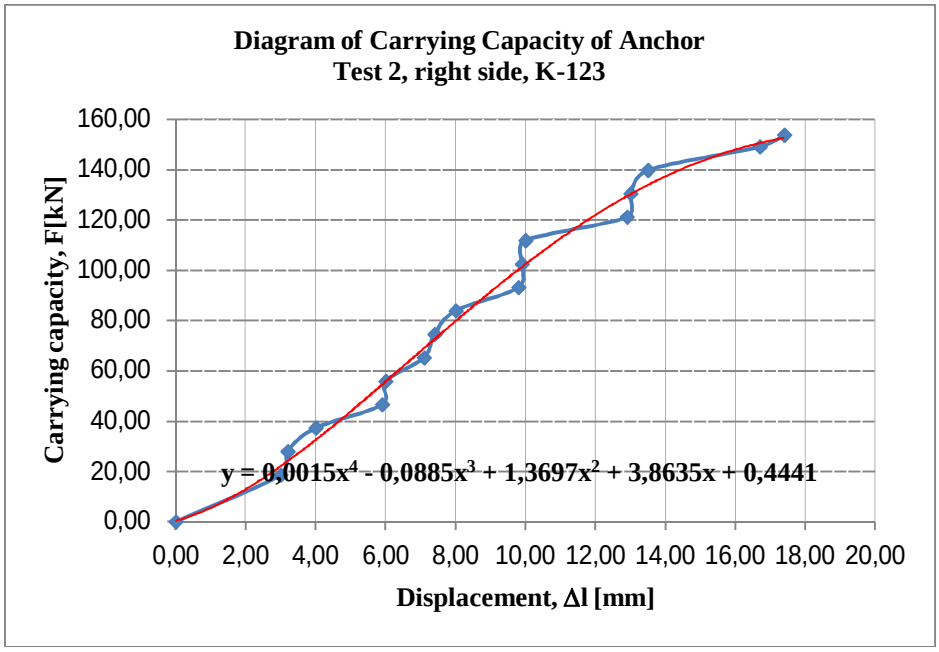


Figure 1.5 *Results of measuring the pull-out force of the second anchor of the second test series*

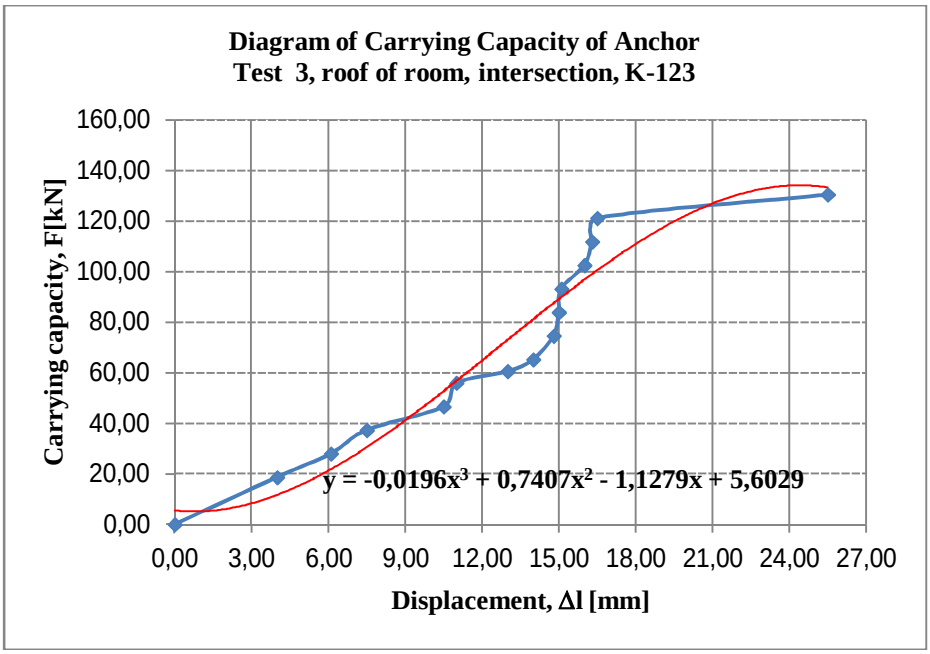


Figure 1.6 *Results of measuring the pull-out force of the third anchor of the second test series*

Values of pull-out forces of anchors were compared with the specification and attest given by the manufacturer, and it can be concluded that the anchors completely fulfill their functions.

2 CONCLUSION

In order to secure the underground stope in the ore body, "T1", the supporting of excavated area is carried out after finished exploitation. The supporting, in this case, is carried out by means of anchors of type SWELLEX and SN, M-20 in a combination with the resin LOKSET RESIN CAPSULES, and reinforcement mesh, which is applied with the layer of torkret concrete.

After tests, which were carried out in the field, it can be concluded that the tested anchors meet the prescribed quality according to the current standard and attest of manufacturer.

REFERENCES

[1] Quarterly Report on the Status of Works on the Ore Exploitation from the Ore Body "T1" in the “Jama” Bor, Mining and Metallurgy Institute Bor, Laboratory for Geomechanics, March 2014;

[2] M. Memić, E. Hadžić, S. Softić, Methodology of Design and Construction the Underground Rooms, Tuzla 1999;

[3] R. Popović, M. Ljubojev, L. Đurđevac Ignjatović, Deformability Parameters for Forming the Stress-strain State Models of Rock Massif, Mining and Metallurgy Engineering Bor, 3/2013, str. 1-6.

[4] V. Milić, I. Svrkota, D. Petrović, Analysis of Block Stability for Semi - Level Caving Method With Kateral Loading, Mining and Metallurgy Engineering Bor, 2/2013, pp. 21-26.

[5] S. Ćosić, M. Avdić, A. Sušić, M. Ljubojev, Finite Element Analysis of Deep Underground Salt, Mining and Metallurgy Engineering Bor, 3/2013, pp. 65-72.

INSTITUT ZA RUDARSTVO I METALURGIJU BOR ISSN: 2334-8836
UDK: 622

UDK: 622.261.2(045)=861 DOI:10.5937/MMEB1401001I

Dragan Ignjatović[*], Lidija Đurđevac Ignjatović[*], Milenko Ljubojev[*], Ivan Ivanov[**]

ISPITIVANJE NOSIVOSTI ANKERA U RUDNOM TELU „T1“[***]

Izvod

U cilju obezbeđenja podzemnog otkopa u rudnom telu „T1“, nakon izvršene eksploatacije se vrši podgrađivanje otkopnog prostora. Podgrađivanje se, u ovom slučaju, izvodi pomoću ankera SWELLEX i SN, M-20 u kombinaciji sa smolom LOKSET RESIN CAPSULES, i armaturnom mrežom, preko koje se nanosi sloj torkret betona.

U ovom radu su prikazani rezultati ispitivanja nosivosti ankera u datom rudnom telu „T1“

Ključne reči: *otkopni prostor, anker, nosivost ankera, sila čupanja*

1. UVOD

U toku podzemnog otkopavanja, uporedo sa eksploatacijom rude, vršeno je podgrađivanje otkopnog prostora. Podgrađivanje se vrši ankerima tipa SWELLEX i SN, M-20 u kombinaciji sa smolom LOKSET RESIN CAPSULES. Podgrađivanju prethodi bušenje bušotina za ugradnju ankera. Bušenje se vrši bušaćom garniturom BOOMER 282. Prečnik bušotina je ∅ 33 mm.

Nakon ugradnje ankera, vršeno je njihovo naprezanje, zatim postavljanje armaturne mreže i nanošenje torkret betona.

Posle svih navedenih radnji vršena su ispitivanja nosivosti ankera na silu čupanja pomoću hidraulične pumpe. Ispitivanje nosivosti ankera je vršeno prema preporukama Međunarodnog društva za mehaniku stena (ISRM).

Pored sile čupanja registrovana su i pomeranja glave ankera. Sila čupanja se nanosi postepeno do dostizanja zadate (radne) ili granične sile čupanja.

Rezultati ispitivanja nosivosti ankera su prikazani grafički dijagramima pomeranja u funkciji sile čupanja.

1.1. Analiza rezultata ispitivanja

Merenja su izvršena u dva navrata (20.11.2013. i 23.01.2014. godine) na 6 ankera, koji su ugrađeni na karakterističnim mestima u rudnom telu T1.

Na slikama 1.1 a, b i c je prikazan izgled ispitivanja ankera u rudnom telu T1.

[*] *Institut za rudarstvo i metalurgiju Bor*

[**] *RBB „Jama“ Bor*

[***] *Ovaj rad je proistekao iz Projekta nauke broj 33021 „Istraživanje i praćenje promena naponsko deformacionog stanja u stenskom masivu „IN SITU“ oko podzemnih prostorija sa izradom modela sa posebnim osvrtom na tunel Kriveljske reke i Jame Bor“, koga finansira Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije*

a)

b)

c)

Sl. 1.1 *a), b) i c). Ispitivanje ankera – određivanje sile čupanja*

U tabeli 1.1 date su vrednosti pomeranja u funkciji od sile čupanja za ispitane ankere.

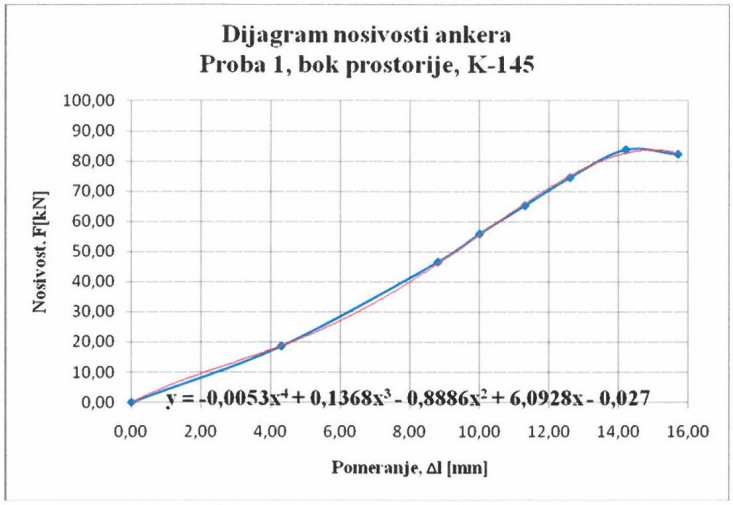
Tabela 1.1. *Vrednosti pomeranja (Δl, [mm]) u funkciji od sile čupanja – nosivosti (F, [kN])*

Anker – mesto ispitivanja					
Proba 1, bok prostorije K-145		**Proba 2, desni bok K-145**		**Proba 3, levi bok, K-145**	
Δl, [mm]	F, [kN]	Δl, [mm]	F, [kN]	Δl, [mm]	F, [kN]
4,30	18,64	7,00	18,64	1,00	9,32
8,80	46,60	-	-	2,60	18,64
10,00	55,92	-	-	3,30	37,28
11,30	65,24	-	-	4,20	46,60
12,60	74,56	-	-	4,80	55,92
14,20	83,88	-	-	5,00	65,24
15,70	82,30	-	-	5,80	74,56
-	-	-	-	7,00	83,88

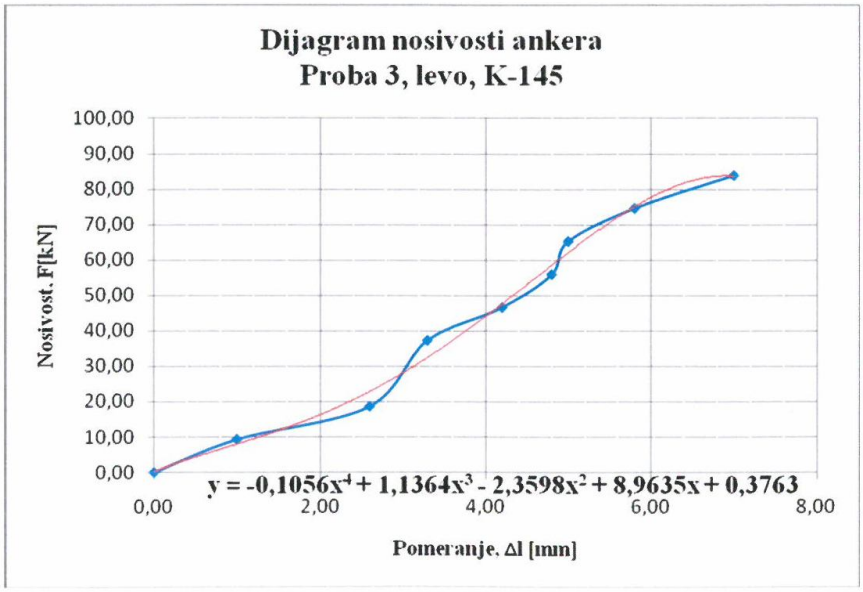
Nastavak tabele 1.1.

Anker – mesto ispitivanja					
Proba 1, desni bok K-123		**Proba 2, desni bok K-123**		**Proba 3, strop prostorije K-123**	
Δl, [mm]	**F, [kN]**	**Δl, [mm]**	**F, [kN]**	**Δl, [mm]**	**F, [kN]**
7,10	18,64	3,00	18,64	2,00	18,64
7,60	27,96	3,20	27,96	6,10	27,96
8,20	37,28	4,00	37,28	7,50	37,28
8,40	46,60	5,90	46,60	10,50	46,60
8,50	55,92	6,00	55,92	11,00	55,92
9,20	65,24	7,10	65,24	13,00	60,58
13,30	74,56	7,40	74,56	14,00	65,24
15,90	83,88	8,00	83,88	14,80	74,56
17,70	93,20	9,80	93,20	15,00	83,88
18,60	102,52	9,90	102,52	15,10	93,20
19,40	111,84	10,00	111,84	16,00	102,52
23,50	121,16	12,90	121,16	16,30	111,84
26,00	130,48	13,00	130,48	16,50	121,16
27,00	135,14	13,50	139,80	25,50	130,48
-	-	16,70	149,12	-	-
-	-	17,40	153,78	-	-

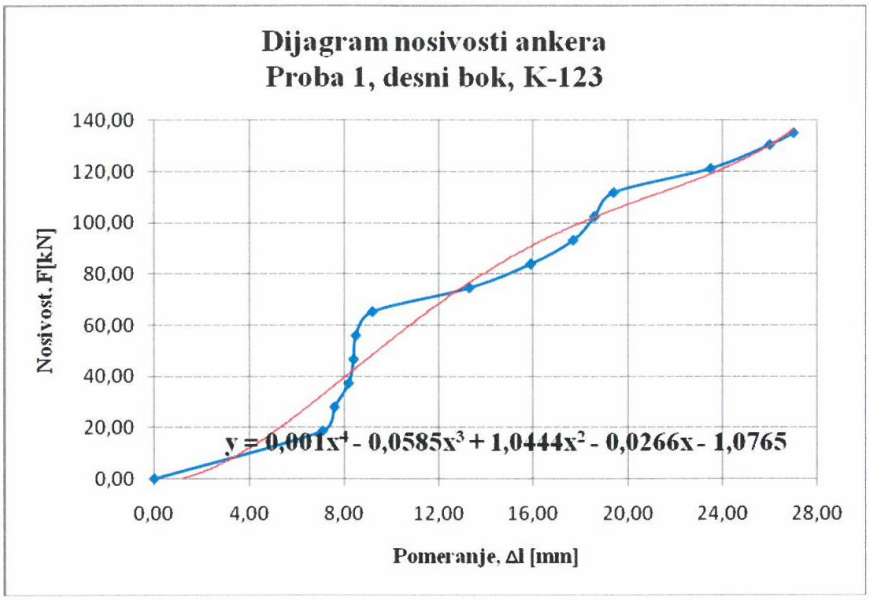
U daljem tekstu su grafički prikazi rezultata merenja sile čupanja.



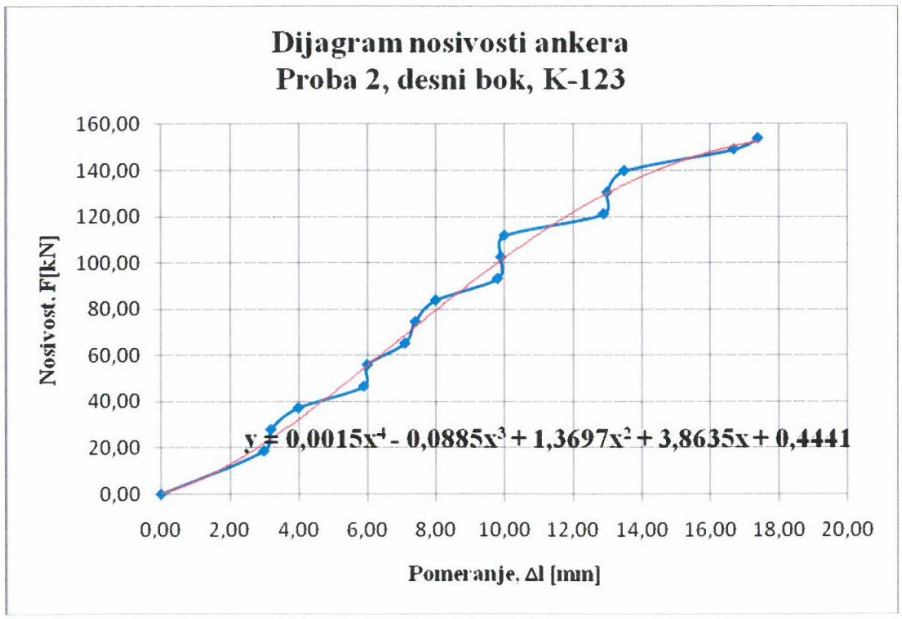
Sl. 1.2. *Rezultati merenja sile čupanja prvog ankera prve serije probe*



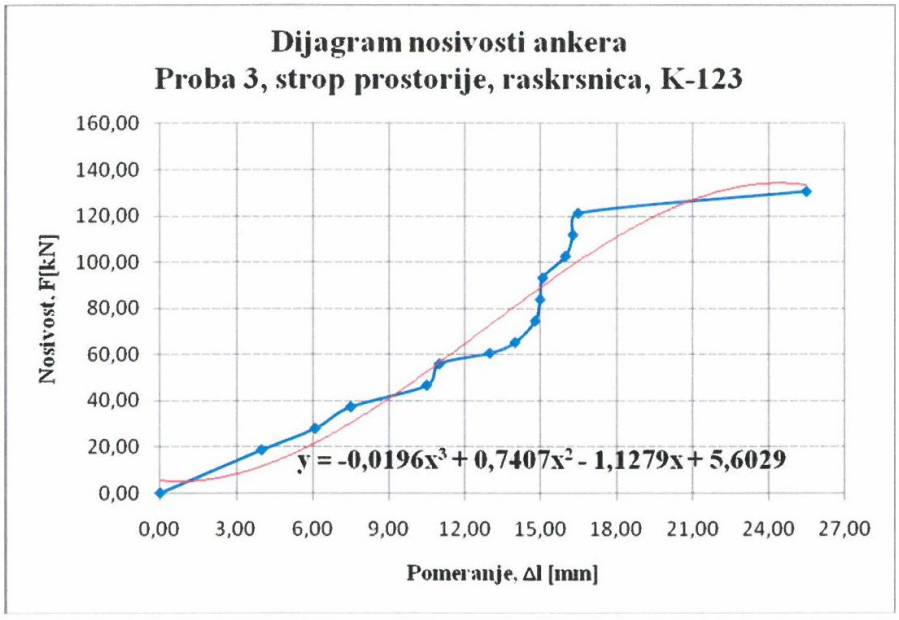
Sl. 1.3. *Rezultati merenja sile čupanja trećeg ankera prve serije probe*



Sl. 1.4. *Rezultati merenja sile čupanja prvog ankera druge serije probe*



Sl. 1.5. *Rezultati merenja sile čupanja drugog ankera druge serije probe*



Sl. 1.6. *Rezultati merenja sile čupanja trećeg ankera druge serije probe*

Vrednosti sila čupanja ankera su upoređene sa specifikacijom i atestom, koje je dao proizvođač, i može se zaključiti da ankeri u potpunosti ispunjavaju svoju funkciju.

2. ZAKLJUČAK

U cilju obezbeđenja podzemnog otkopa u rudnom telu „T1“, nakon izvršene eksploatacije se vrši podgrađivanje otkopnog prostora. Podgrađivanje se, u ovom slučaju, izvodi pomoću ankera SWELLEX i SN, M-20 u kombinaciji sa smolom LOKSET RESIN CAPSULES, i armaturnom mrežom, preko koje se nanosi sloj torkret betona.

Nakon ispitivanja, koja su izvršena na terenu, može se zaključiti da ispitani ankeri zadovoljavaju propisani kvalitet prema važećem standardu i atestu proizvođača.

LITERATURA

[1] Kvartalni izveštaj o stanju radova na eksploataciji rude iz rudnog tela „T1“ jame Bor, Institut za rudarstvo i metalurgiju Bor, Laboratorija za geomehaniku, mart, 2014.

[2] M. Memić, E. Hadžić, S. Softić, Metodologija projektovanja i izgradnje podzemnih prostorija, Tuzla 1999.

[3] R. Popović, M. Ljubojev, L. Đurđevac Ignjatović, Parametri deformabilnosti za formiranje modela naponsko-deformacijskog stanja stenskog maxsiva, Mining and Metallurgy Engineering Bor, 3/2013, str. 7-12.

[4] V. Milić, I. Svrkota, D. Petrović, Istraživanje stabilnosti dna otkopnog bloka za metodu poluetažnog prinudnog zarušavanja sa jednostranim bočnim utovarom rude, Mining and Metallurgy Engineering Bor, 2/2013, str. 27-32.

[5] S. Ćosić, M. Avdić, A. Sušić, M. Ljubojev, Naponsko - deformaciona analiza sonih komora metodom konačnih elemenata, Mining and Metallurgy Engineering Bor, 3/2013, pp. 73-80.